Patent
Attorney Docket No. 85773-28C

# IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

**In Re:** Continuation Application of U.S. Patent Application no. 08/996,996, filed December 23, 1997

**Inventors:** JIN, Xin et al.

**For:** **METHOD AND APPARATUS FOR REGULATION OF THE EFFECTIVE NOISE FIGURE IN A CDMA RECEIVER**

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## PRELIMINARY AMENDMENT

Assistant Commissioner for Patents
Washington, D.C. 20231

Sir/Madam:

Please amend this application as follows and examine the application in view of the amendments and remarks provided.

## I. AMENDMENTS

**In the Specification**

Please replace the paragraph beginning at page 1, line 13, with the following rewritten paragraph:

-- In a CDMA wireless system the activation or deactivation of a cell/sector affects the network. The sudden activation of the cell/sector causes a sudden

increase in the total forward link power. This may temporarily degrade the forward link performance of the network and possibly cause the calls in other cells/sectors close to the activating cell/sector to be dropped due to the sudden increase of channel interference from the activating cell/sector. In addition, the sudden deactivation of a cell/sector will result in calls in the cell/sector being dropped. To avoid this problem, when a cell/sector is activated in a CDMA wireless system, the transmitted power of the transmitter at the base station is increased gradually, while the effective noise figure of the receiver at the base station is gradually decreased accordingly. This allows the users in the neighboring cells/sectors who are subject to the interference from the activating cell/sector to have enough time to handoff to the activating cell/sector. The synchronized gradual increase of the transmitted power and decrease in the receiver effective noise figure is known as "blossoming". Similarly, the synchronized gradual decrease in the transmitted power and increase in the receiver effective noise figure is known as "wilting". This occurs when a cell/sector is deactivated. Wilting allows the users in the deactivating cell/sector to have enough time to handoff to neighboring cell/sectors, rather than being dropped. During normal operation of the cell/sector the balance between the forward link handoff boundary and the reverse link handoff boundary must be constantly maintained. This operation, known as "breathing", is also effected by balancing the transmitted power and the effective noise figure at the receiver. In order to keep the handoff boundaries balanced, for every one dB change in transmitted power there must be an opposing one dB change in the

receiver effective noise figure. --

Please replace the paragraph beginning at page 4, line 1, with the following rewritten paragraph:

-- The effective noise figure regulation may be effected in the analog processing unit or the digital processing unit of each channel. In a specific embodiment the channels of the receiver process independent CDMA signals separated by frequency. Most preferably, the effective noise figure regulation unit is located in the digital processing unit of the channel. The effective noise figure regulation unit includes a source of noise, such as a synthesized pseudo-random noise that is injected in the signal path. For easier control it is preferred to inject the signal at the digital baseband stage. At the baseband stage, the noise can be injected in the signal before or after the channel select filter. To determine the amount of noise to inject into the signal path for a given effective noise figure change, a power detector is used to measure the actual receiver noise power. Based on the information supplied by the power detector, the noise source can be controlled to effectively regulate the receiver effective noise figure degradation. --

Please replace the paragraph beginning at page 4, line 26, with the following rewritten paragraph:

-- An important advantage of this arrangement is the ability to regulate the effective noise figure on a channel by channel basis. Since each channel of the CDMA receiver

has an independent effective noise figure regulation unit, the amount of noise introduced in the signal path of each channel may vary from one channel to another. --

Please insert the following new paragraph at page 5, line 18:

-- Figure 2 is a detailed block diagram of a digital processing stage of the CDMA receiver shown in Figure 1; --

Please replace the paragraph beginning at page 5, line 19, with the following rewritten paragraph:

-- Figure 3 is a detailed block diagram of the noise generator used in the CDMA receiver depicted at Figure 1; and --

Please replace the paragraph beginning at page 5, line 22, with the following rewritten paragraph:

-- Figure 4 is a block diagram of a device that can be used to generate pseudo-random noise. --

Please replace the paragraph beginning at page 5, line 26, with the following rewritten paragraph:

-- Figure 1 of the annexed drawings illustrates a CDMA receiver implementing the regulation function of effective noise figure in accordance with the present invention. The

receiver comprises a plurality of antennas 100. In the example shown, N different antennas are provided, the antennas may be from different sectors of a given cell, for example. The RF signal received by a given antenna is then introduced into M separate channels. Those channels share a common analog processing stage 102. In the example shown, the common analog processing stage 102 includes a frequency downconverter, whose function is to reduce the frequency of the received signal to a certain IF frequency. The analog processing stage may also include frequency selective filters. For simplicity, those components are not detailed in the drawings because they are known to those skilled in the art. The signal generated by the common analog processing stage 102 is supplied to an analog to digital converter (ADC) 104, also common to the M channels. The analog to digital converter 104 digitizes the input signal that is then supplied to an array 106 of digital processing units for each channel. Each digital processing unit of the array 106, as shown in Figure 2, includes a quadrature downconverter functional block 108 that leads to a channel select filter 110. The structure and operation of the quadrature downconverter functional block 108 and of the channel select filter 110 do not need to be described in detail because these components are well known to the person skilled in the art. --

Please replace the paragraph beginning at page 7, line 17, with the following rewritten paragraph:

-- Figure 3 of the annexed drawings provides a detailed illustration of the construction of the noise

generator 114. The noise generator 114 provides two independent noise streams for the in-phase and quadrature signals in each path. More specifically, the noise generator includes a source 116 of synthetic pseudo-random noise and a companion source of synthetic pseudo-random noise 118, the source 116 being used to condition the in-phase signal while the source 118 being used for the quadrature signal. Most preferably, the noise sources 116 and 118 are of equal power output, Gaussian distribution and they are uncorrelated to one another. The output of each noise source is multiplied by a weighing factor that determines the amount of noise injected in the in-phase signal and in the quadrature signal. As for the mechanism for injecting the noise signals, it is effected by simple addition. The variance of the noise injected to the signal path as measured by the power detector 112 can be defined by the following equation: --

Please replace the paragraph beginning at page 10, line 17, with the following rewritten paragraph:

-- Figure 4 illustrates in greater detail the internal construction of any one of the noise sources 116,118. The source includes a $p^{th}$ order pseudo-noise generator 122 that receives a clock signal at a frequency $f'_s$. The output of this pseudo-noise generator that is either 1 or -1 (0) is supplied to a sum and dump functional block 124 that essentially adds R consecutive code strings issued from the generator 122 and dumps the result at the output. The rate of the output is 1/R multiplied by the code rate $f'_s$ of the pseudo-noise generator. As for the particular algorithm

used for generating the pseudo-noise code strings based on an input clock signal, it is not deemed necessary to describe it herein because algorithms of this type are generally well known to those skilled in the art. --

Please replace the paragraph beginning at page 10, line 32, with the following rewritten paragraph:

-- There are many possible variants for implementing the invention. For instance, some of the functions part of the digital processing stage for each channel depicted at Figure 1, can be implemented with analog circuits. Namely, such analog stage may include the quadrature downconverter, analog channel selective filters (IF or baseband). The noise figure regulation means can be made part of such analog stage by providing a source of synthetic pseudo-random noise or analog random noise source that is injected in the signal path through an analog adder at baseband or IF stage. Still, such analog stage is part of the individual channel to enable independent regulation of the effective noise figure on a channel by channel basis. Based on the choices which part(s) are/is implemented by analog circuits, the location of the ADC should vary accordingly. --

**In the Claims**

Kindly delete claims 5, 7 and 9 from the application without prejudice or disclaimer.

Kindly amend the remaining claims as follows:

1. (once amended) A CDMA receiver, comprising:
   - an input for receiving an RF signal that includes a plurality of components separable from one another;
   - an analog signal processing stage connected to said input for processing the RF signal;
   - a plurality of channels connected to said analog signal processing stage, each channel receiving a signal derived from a respective component of the RF signal, each channel including an effective noise figure regulation unit operative to generate a noise signal and introduce the noise signal into the signal derived from the respective component of the RF signal for regulating an effective noise figure of the signal derived from the respective component of the RF signal, said noise figure regulation unit further operative to regulate a variance of the noise signal.

2. (once amended) The receiver as defined in claim 1, wherein said effective noise figure regulation unit includes a noise generator to generate said noise signal.

4. (once amended) The receiver as defined in claim 3, wherein said noise figure regulation unit is operative to measure a power of the signal derived from a respective component of the RF signal including the noise signal.

6. (once amended) A method for regulating an effective noise figure of a signal in a multi-channel CDMA receiver, said method comprising:
   - acquiring a signal;
   - separating the signal into a plurality of components;
   - introducing each component in a respective channel of the CDMA receiver;
   - in each channel, generating a noise signal and introducing the noise signal into the component received in the channel, for regulating an effective noise figure of the component independently from other channels of the CDMA receiver; and
   - in each channel, measuring a power of the component including the noise signal to compute a variance of the noise signal.

8. (once amended) The method as defined in claim 6, wherein said noise generator produces either one of a random and pseudo-random noise.

## II. REMARKS

### A. Summary of Amendments

Amendments have been made to the specification to correct certain grammatical and orthographic informalities and to provide consistency with the claims and formal drawings. The Applicant respectfully submits that no new matter has been added to the specification.

Claims 5, 7 and 9 have been deleted from the application, and claims 1-2, 4, 6 and 8 have been amended, in order to hasten allowance of the claims.

Attached hereto is a marked-up version of the changes made to the specification and claims by current amendment. The attached marked-up version is captioned "**Version with markings to show changes made**".

**B. Remarks**

In the parent patent application serial no. 08/996,996, filed December 23, 1997, the Examiner rejected former claims 1-4, 6 and 8 under 35 U.S.C. §102(b) as being anticipated by U.S. Patent No. 5,267,262 (Wheatley, III).

The attention of the Examiner is drawn to the following limitation of amended claim 1:

> "... **said noise figure regulation unit further operative to regulate a variance of the noise signal.**"

Wheatley does not disclose, teach nor suggest the above limitation. In particular, Wheatley does not disclose a CDMA receiver having a noise figure regulation unit within each channel of the receiver, where this noise figure regulation unit is operative to regulate a variance of the noise signal.

Accordingly, the Applicant respectfully submits that Wheatley does not anticipate nor render obvious the subject matter of amended claim 1 and that, as such, amended claim

1 is of a patentable nature.

Claims 2-4 depend from claim 1 and, as such, are also believed to be of a patentable nature.

Claim 6 as amended includes the following limitations:

> **" ... in each channel, measuring a power of the component including the noise signal to compute a variance of the noise signal."**

Wheatley does not disclose, teach nor suggest the above limitation. Accordingly, the Applicant respectfully submits that Wheatley does not anticipate nor render obvious the subject matter of amended claim 6 and that, as such, amended claim 6 is of a patentable nature.

Claim 8 depends from claim 6 and, as such, is also believed to be of a patentable nature.

## III. CONCLUSION

In view of the above, it is submitted that claims 1-4, 6 and 8 are in condition for allowance. Allowance of claims 1-4, 6 and 8 at an early date is solicited.

If the claims of the application are not considered to be in full condition for allowance, for any reason, the Applicant respectfully requests the constructive assistance and suggestions of the Examiner in drafting one or more acceptable claims or in making constructive suggestions so that the application can be placed in allowable condition

as soon as possible and without the need for further proceedings.

Respectfully submitted,

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Date: March 27, 2001

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**VERSION WITH MARKINGS TO SHOW CHANGES MADE**

**In the specification:**

Paragraph beginning at line 13 of page 1 has been amended as follows:

In a CDMA wireless system the activation or deactivation of a cell/sector affects the network. The sudden activation of the cell/sector causes a sudden increase in the total forward link power. This may temporarily degrade the forward link performance of the network and possibly cause the calls in other cells/sectors close to the activating cell/sector to be dropped due to the sudden increase of channel interference from the activating cell/sector. In addition, the sudden deactivation of a cell/sector will result in calls in the cell/sector ~~been~~ being dropped. To avoid this problem, when a cell/sector is activated in a CDMA wireless system, the transmitted power of the transmitter at the base station is increased gradually, while the effective noise figure of the receiver at the base station is gradually decreased accordingly. This allows the users in the neighboring cells/sectors who are subject to the interference from the activating cell/sector to have enough time to handoff to the activating cell/sector. The synchronized gradual increase of the transmitted power and decrease in the receiver effective noise figure is known as "blossoming". Similarly, the synchronized gradual decrease in the transmitted power and increase in the receiver effective noise figure is known as "wilting". This occurs when a

cell/sector is deactivated. Wilting allows the users in the deactivating cell/sector to have enough time to handoff to neighboring cell/sectors, rather than being dropped. During normal operation of the cell/sector the balance between the forward link handoff boundary and the reverse link handoff boundary must be constantly maintained. This operation, known as "breathing", is also effected by balancing the transmitted power and the effective noise ~~Figure~~ figure at the receiver. In order to keep the handoff boundaries balanced, for every one dB change in transmitted power there must be an opposing one dB change in the receiver effective noise figure.

Paragraph beginning at line 1 of page 4 has been amended as follows:

The effective noise figure regulation may be effected in the analog processing unit or the digital processing unit of each channel. In a specific embodiment the channels of the receiver process independent CDMA signals separated by frequency. Most preferably, the effective noise ~~power~~ figure regulation ~~means~~ unit is located in the digital processing unit of the channel. The effective noise ~~power~~ figure regulation ~~means~~ unit includes a source of noise, such as a synthesized pseudo-random noise that is injected in the signal path. For easier control it is preferred to inject the signal at the digital baseband stage. At the baseband stage, the noise can be injected in the signal before or after the channel select filter. To determine the amount of noise to inject into the signal path for a given effective noise figure change, a power

detector is used to measure the actual receiver noise power. Based on the information supplied by the power detector, the noise source can be controlled to effectively regulate the receiver effective noise figure degradation.

Paragraph beginning at line 26 of page 4 has been amended as follows:

An important advantage of this arrangement is the ability to regulate the effective noise figure on a channel by channel basis. Since each channel of the CDMA receiver has an independent effective noise figure regulation ~~means~~ unit, the amount of noise introduced in the signal path of each channel may vary from one channel to another.

New paragraph beginning at line 18 of page 5 has been added:

Figure 2 is a detailed block diagram of a digital processing stage of the CDMA receiver shown in Figure 1;

Paragraph beginning at line 19 of page 5 has been amended as follows:

Figure ~~2~~ 3 is a detailed block diagram of the noise generator used in the CDMA receiver depicted at Figure 1; and

Paragraph beginning at line 22 of page 5 has been amended as follows:

Figure ~~3~~ 4 is a block diagram of a device that can be used to generate pseudo-random noise.

Paragraph beginning at line 26 of page 5 has been amended as follows:

Figure 1 of the annexed drawings illustrates a CDMA receiver implementing the regulation function of effective noise ~~Figure~~ figure in accordance with the present invention. The receiver comprises a plurality of antennas 100. In the example shown, N different antennas are provided, the antennas may be from different sectors of a given cell, for example. The RF signal received by a given antenna is then introduced into M separate channels. Those channels share a common analog processing stage 102. In the example shown, the common analog processing stage 102 includes a frequency downconverter, whose function is to reduce the frequency of the received signal to a certain IF frequency. The analog processing stage may also include frequency selective filters. For simplicity, those components are not detailed in the drawings because they are known to those skilled in the art. The signal generated by the common analog processing stage 102 is supplied to an analog to digital converter (ADC) 104, also common to the M channels. The analog to digital converter 104 digitizes the input signal that is then supplied to ~~a~~ an array 106 of digital processing units for each channel. Each digital processing unit of the array 106, as shown in Figure 2, includes a quadrature downconverter functional block 108 that leads to a channel select filter 110. The structure and operation of the quadrature downconverter

functional block 108 and of the channel select filter 110 do not need to be described in detail because these components are well known to the person skilled in the art.

Paragraph beginning at line 17 of page 7 has been amended as follows:

Figure ~~2~~ 3 of the annexed drawings provides a detailed illustration of the construction of the noise generator 114. The noise generator 114 provides two independent noise streams for the in-phase and quadrature signals in each path. More specifically, the noise generator includes a source 116 of synthetic pseudo-random noise and a companion source of synthetic pseudo-random noise 118, the source 116 being used to condition the in-phase signal while the source 118 being used for the quadrature signal. Most preferably, the noise sources 116 and 118 are of equal power output, Gaussian distribution and they are uncorrelated to one another. The output of each noise source is multiplied by a weighing factor that determines the amount of noise injected in the in-phase signal and in the quadrature signal. As ~~to~~ for the mechanism for injecting the noise signals, it is effected by simple addition. The variance of the noise injected to the signal path as measured by the power detector 112 can be defined by the following equation:

Paragraph beginning at line 17 of page 10 has been amended as follows:

Figure ~~3~~ 4 illustrates in greater detail the internal construction of any one of the noise sources 116,118. The source includes a $p^{th}$ order pseudo-noise generator 122 that receives a clock signal at a frequency $f'_s$. The output of this pseudo-noise generator that is either 1 or -1 (0) is supplied to a sum and dump functional block 124 that essentially adds R consecutive code strings issued from the generator 122 and dumps the result at the output. The rate of the output is 1/R multiplied by the code rate $f'_s$ of the pseudo-noise generator. As ~~to the to~~ for the particular algorithm used for generating the pseudo-noise code strings based on an input clock signal, it is not deemed necessary to describe it herein because algorithms of this type are generally well known to those skilled in the art.

Paragraph beginning at line 32 of page 10 has been amended as follows:

There are many possible variants for implementing the invention. For instance, some of the functions part of the digital processing stage for each channel depicted at Figure 1, can be implemented with analog circuits. Namely, such analog stage may include the quadrature downconverter, analog channel selective filters (IF or baseband). The noise figure regulation means can be made part of such analog stage by providing a source of synthetic pseudo-random noise or analog random noise source that is injected in the signal path through an analog adder at baseband or IF stage. Still, such analog stage is part of the individual channel to enable independent regulation of the effective noise ~~power~~ figure on a channel by channel basis.

Based on the choices which part(s) are/is implemented by analog circuits, the location of the ADC should vary accordingly.

**In the claims:**

Claims 5, 7 and 9 have been canceled.

The remaining claims have been amended as follows:

1. (once amended) A CDMA receiver, comprising:
   - an input for receiving an RF signal that includes a plurality of components separable from one another;
   - an analog signal processing stage connected to said input~~, said analog processing stage~~ for processing ~~said~~ the RF signal ~~that includes a plurality of components separable from one another~~;
   - a plurality of channels connected to said analog signal processing stage, each channel receiving a signal derived from a respective component of ~~said~~ the RF signal, each channel including an effective noise figure regulation ~~means~~ unit operative to ~~regulate an effective noise power figure the component processed by the channel~~ generate a noise signal and introduce the noise signal into the signal derived from the respective component of the RF signal for regulating an effective noise figure of the signal derived from the respective component of

the RF signal, said noise figure regulation unit further operative to regulate a variance of the noise signal.

2. (once amended) The receiver as defined in claim 1, wherein said effective noise figure regulation ~~means comprising~~ unit includes a noise generator to generate ~~a~~ said noise signal ~~and means to introduce the noise signal into the component of the received RF signal~~.

4. (once amended) The receiver as defined in claim 3, wherein said noise ~~power~~ figure regulation ~~means includes means for measuring~~ unit is operative to measure a power of the signal derived from a respective component of the RF signal including the noise signal.

6. (once amended) A method for regulating an effective noise figure of a signal in a multi-channel CDMA receiver, said method comprising ~~the steps of~~:

- acquiring a signal;
- separating ~~said~~ the signal into a plurality of components;
- introducing each component ~~of said signal~~ in a respective channel of the CDMA receiver; ~~and~~
- in each channel, generating a noise signal and introducing the noise signal into the component received in the channel, for regulating an effective noise ~~power~~ figure of the ~~signal~~ component ~~processed in the channel~~ independently from other channels of the CDMA receiver; and

- in each channel, measuring a power of the component including the noise signal to compute a variance of the noise signal.

8. (once amended) The method as defined in claim [7] 6, wherein said noise generator produces either one of a random and pseudo-random noise.